A REVISION OF THE SOUTHERN AUSTRALIAN STARFISH GENUS *NECTRIA* (ASTEROIDEA: OREASTERIDAE), WITH THE DESCRIPTION OF A NEW SPECIES

by

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ABSTRACT

ZEIDLER, W., and ROWE, F. W. E. 1986. A revision of the southern Australian starfish genus *Nectria* (Asteroidea: Oreasteridae), with the description of a new species. *Rec. S. Aust. Mus.* 19(9): 117-138.

The status of the genus *Nectria* is discussed and the genus transferred from the family Goniasteridae to the family Oreasteridae. A previously closely allied genus, *Nectriaster*, is also transferred to the Oreasteridae. The status of the subfamily Nectriinae is discussed and maintained for the unique genus *Nectria*. A new subfamily, Oreasterinae, is erected for the remaining genera of the family Oreasteridae including *Nectriaster*. Problems relating to Gray's (1840, 1847a, b) misunderstanding of *N. ocellifera* which he based on Oudart's (1827) figure of Lamarck's species are discussed and Oudart's figure is reproduced for the first time. Eight species are currently recognised including a new species from Tasmania. Each of the eight species is diagnosed and geographic ranges detailed. A lectotype is selected for *N. ocellata* Perrier. *N. pedicelligera* Mortensen is recognised as a valid species restricted to the southern Australian coast. The species potential of the genus is considered not yet to have been reached. *Nectria* is recognised as an endemic southern Australian genus.

INTRODUCTION

Although *Nectria* is a well established southern Australian genus and is easily recognisable, there has been some confusion regarding the type species and the identity of a number of the species despite the reviews of Clark (1966) and Shepherd (1967).

We have examined all available type material for each of the species together with the collections held in the Australian Museum Sydney (AM); Museum of Victoria, Melbourne (MV) (specimens not measured); South Australian Museum, Adelaide (SAM); Western Australian Museum, Perth (WAM); Tasmanian Museum and Art Gallery, Hobart (TM); Queen Victoria Museum and Art Gallery, Launceston (QVM) (specimens not measured) and Museum of Comparative Zoology, Harvard, U.S.A. (MCZ). Following our examination of this material it is apparent that Clark (1966) and Shepherd (1967) did not appreciate the limits of the species.

We have also obtained a copy of Oudart's (1827) figure of *Asterias ocellifera* Lamarck 1816 (there is no accompanying text) which was used by Gray to identify his specimens when he established the genus *Nectria*. This figure has apparently not been sighted since Perrier (1875) and we reproduce it here (Fig. 1) in order to clarify the confused situation created by Gray's (1840, 1847a, b) use of this figure.

We are now able to recognise eight species of *Nectria* one of which is new to science. We are further able to detail the distribution of these eight species.

Nectria is transferred to the family Oreasteridae but the status of the subfamily Nectriinae is maintained.

The following additional abbreviations are used in the text.

BMNH = British Museum (Natural History)
MNHN = Museum National D'Histoire Naturelle, Paris
NSW = New South Wales
SA = South Australia
Tas = Tasmania
Vic = Victoria
WA = Western Australia

SYSTEMATICS

Family **OREASTERIDAE** Fisher, 1911

Subfamily **Nectriinae** Perrier, 1894

Genus *Nectria* Gray, 1840

Nectria Gray, 1840 (1841): 287; 1866: 15; Dujardin & Hupé, 1862: 406; Perrier, 1875: 185; 1876: 1; 1894: 333; Viguier, 1878: 187; H. L. Clark, 1946: 85; A. M. Clark, 1966: 309.

Diagnosis: An oreasterid genus with 5 tapering arms (R up to 125 mm) and relatively large disc (r up to 45 mm). Abactinal surface convex, actinal surface flat. Abactinal skeleton comprises distinctive raised tabulae each supported by 6 radiating ossicles at the base forming a network. Disc tabulae crowned with peripheral ring of usually prominant granules encircling central granules, remainder with granules of varying shape and size. Tabulae distinguished on disc, decreasing in size along arm to about ½ R after which they become unrecognisable as tabulae. Marginal plates obvious, flat, squarish, infero- and supero-marginals of similar size and number decreasing regularly in size

to arm tip, covered with even-sized granules. Actinal plates up to 6-8 rows at base of rays, decreasing distally, covered with coarse granules. Adambulacral plates with furrow spines being little larger than adjacent granules on actinal plates. Papulae in discrete groups between radiating ossicles of dorsal skeleton sometimes occurring between marginal plates but rarely on actinal surface immediately below inferomarginal plates. Interradial septae partially calcified. Pedicellariae often present (Fig. 2). Superambulacral plates present.

Nectria is an endemic Australian genus occurring from the mid-west coast of Western Australia (Houtman Abrolhos) along the southern coast to Broughton I. off Port Stephens, N.S.W. in the east (Fig. 3). Records of specimens from Fiji (Sladen 1889), New Zealand (Mortensen 1925) and Mauritius (MV specimen) are erroneous. Species occur from the shoreline down to 550 m and are recorded from habitats associated with rocky reefs.

Remarks: The genus was established by Gray (1840) based on a specimen or specimens without locality data which he identified as *Asterias ocellifera* Lamarck, 1816 (as "*oculifera*" lapsus cal.) using Oudart's (1827) figure (Fig. 1) of Lamarck's species. However we have determined that of the few dried specimens of *Nectria* in the BMNH from the mid-19th century likely to have been seen by Gray (1840), none are *N. ocellifera*. One specimen in particular (BMNH; 1953: 4.27.24) (Fig. 6b) which was certainly seen by Gray "as its oldest label has '*Nectria oculifera*' stuck on the back of the board with '= *Asterias ocellifera* Lamarck' below and 'Gray' pencilled after *oculifera*" (A. M. Clark, pers. comm.) is clearly *N. ocellata*.

Thus like Perrier (1875) we conclude that Gray (1840) mistook one species for the other. Clearly Gray never saw a specimen of *N. ocellifera* for later (1847a, b) he identified a specimen as *Patiria ocellifera*, noting that he may have mis-identified the BMNH *Nectria* since he says "this species [*P. ocellifera*] more nearly resembles Oudart's figure than the species I have described under the name *Nectria oculifera*". In shape, but not structure, *N. ocellifera* resembles *P. ocellifera* more so than does *N. ocellata*. We regard Gray's (1847a) *Patiria ocellifera* another mis-identification based on Oudart's figure and not a description of a new species. However, Clark (1963) has redescribed and figured Gray's specimen of *P. ocellifera* as the holotype of that species since she does not consider Gray mis-identified the specimen.

The above confusion raises the problem of whether *ocellifera* or *ocellata* should now be the type species of the genus. Although H. L. Clark (1946) has stated "*Asterias ocellifera* is the type species of *Nectria* we concur with A. M. Clark (1966) in that "strictly speaking, *N. ocellata* Perrier might be considered as the type species since that is the one that Gray had before him when he diagnosed the genus *Nectria*, though he mistakenly identified it with Lamarck's species." According to Article 70a of the International Code of Zoological Nomenclature (ICZN) a decision on such a matter should be left to the Commission.

Nectria was first placed in the family Pentacerotidae by Gray (1840); subsequently Perrier (1875) included the genus in the Goniasteridae, dropping all reference to the Pentacerotidae. Later (1894) Perrier placed the genus in its own subfamily the Nectriinae on the basis of the distinctive tabulae. Following the examination of two specimens Fisher (1911) maintained the subfamilial status in the family Goniasteridae on the basis of the presence of intermarginal papulae which he considered a most important character; he also described the occurrences of superambulacral plates in a number of goniasterid genera including *Nectria*. Spencer and Wright (1966) uphold Nectriinae on the same basis as Fisher (1911). They include within the subfamily one other genus, *Nectriaster* H. L. Clark, 1946. However, we transfer both of these genera to the family Oreasteridae, since, like such genera as *Oreaster* and *Pentaceraster*, *Nectria* has a substantially complete calcareous interbrachial septum, and *Nectriaster* possesses a complete, calcareous interbrachial septum. The interbrachial septum of goniasterids is typically membranous. Also, in both *Nectria* and *Nectriaster*, the alignment of marginal plates, their granulose covering, and the arrangement of abactinal plates in particular, are similar to other oreasterids.

The relationship between *Nectria* and *Nectriaster* does not appear as close as that suggested by H. L. Clark (1946) and subsequent authors. Indeed the dorsal armament of *Nectriaster* is not unlike that of *Oreaster* and *Pentaceraster*, to which it may be considered more closely aligned. However, the distinctive abactinal tabulae of *Nectria* stands it apart from all other oreasterids and for this reason we prefer to retain the subfamily Nectriinae, as did Perrier, but within the family Oreasteridae. With the recognition of this subfamily for the type-genus *Nectria*, the remaining genera within the Oreasteridae should be referred (until otherwise revised) to the nominative subfamily **Oreasterinae sub.fam.nov.** which is diagnosed herein as a subfamily of Oreasteridae which lacks tabulae and for which *Oreaster* is nominated as the type-genus.

Clearly, however, the family Oreasteridae is in need of critical reappraisal.

KEY TO THE SPECIES OF *NECTRIA*

1 Intermarginal papulae present, when absent many distal arm plates enlarged 2
— Intermarginal papulae absent, distal arm plates never enlarged 5
2 Tabulae with concave aspect, with central granules lower in profile and smaller than peripheals ..... *N. macrobrachia*
— Tabulae with convex aspect, with central granules higher in profile and larger than peripherals 3

3 Dorsal arm plates decrease regularly in size towards arm tip; pedicellariae with slender valves ..... *N. pedicelligera*
— Dorsal arm plates of mixed sizes towards arm tip, some almost as large as disc plates; pedicellariae with slender or broad valves 4
4 Furrow spines 4-6 (rarely 3 or 7); pedicellariae common with broad valves; intermarginal papulae always present ..... *N. multispina*
— Furrow spines 3-4 (rarely 2) pedicellariae rare with slender valves; intermarginal papulae sometimes absent ..... *N. saoria*
5 Tabulae low about 1 mm high ... *N. humilis* sp.nov.
— Tabulae well developed more than 1 mm high 6
6 Marginal plates with granules distinctly smaller than on actinal surface; tabulae with very low, flat central granules and radiating scale-like peripheral granules R/r = 2.65 ± 0.06 (±95% c.l.) ..... *N. ocellifera*
— Marginal plates with coarse granules or granules similar to actinal surface; tabulae with central granules rarely flat, peripheral granules wedge-shaped sometimes radiating. If marginal plates with fine granulation and tabulae with low flat central granules, then peripherals not radiating and R/r = 3.11 ± 0.12 (±95% c.l.) .. 7
7 Tabulae with peripheral and central granules few in number (usually each < 20), irregular in size and shape, round in cross-section, peripherals radiating; dorsal arm plates always indistinct distally with enlarged central granules ..... *N. wilsoni*
— Tabulae with numerous peripheral and central granules (usually > 20, often > 30), usually regular in size and shape, peripherals forming compact ring around centrals, rarely radiating; central granules convex, usually crowded, larger than peripherals, dorsal arm plates with more or less distinct limits distally and with central granules not prominent (FORM 1); central granules irregular in size, dorsal arm plates indistinct distally with central granule or granules prominent (as in *wilsoni*) (FORM 2); central granules lower than peripherals, becoming flat in extreme cases (as in *ocellifera*), dorsal arm plates with distinct limits distally and with even granulation (FORM 3) . *N. ocellata*

Nectria ocellifera (Lamarck)
(Figs 1 & 4a)

Asterias ocellifera Lamarck, 1816: 553; 1840: 239 (part); Oudart, 1827: plate 1.

Goniodiscus ocelliferus: Müller & Troschel, 1842: 60.

Nectria ocellifera: Dujardin & Hupé, 1862: 406; Perrier, 1869: 283; 1875: 187; 1876: 3; H. L. Clark, 1914: 139; 1916: 35; 1928: 379 (key); 1946: 86; Shepherd, 1967: 464, fig. 3 (part); Marsh, 1976: 217 (table).

Nectria ocellata: Shepherd, 1967: 467 (part).

Material examined: Holotype, MNHN; ECAS 670 (R/r = 55/20 mm), mers australes?, Péron et Lesueur, 1803 (Shepherd (1967) has suggested that the type probably came from Geographe Bay, W.A.).

In addition 65 specimens from WAM, 3 specimens from AM and one specimen from MCZ.

Diagnosis: R up to 75 mm, r up to 30 mm. R/r = 2.65 ± 0.06 (±95% c.l.). Tabulae with central granules irregular in size and shape, flat, very low in profile (approx. 0.2 mm above tabula), slightly spaced, angular in cross-section. Peripheral granules radiating, about twice as long as wide, up to 1 mm high, thin, scale-like, tapering to rounded tip. Tabulae more or less confined to disc. Dorsal arm plates slightly convex, decreasing in size towards arm tip, with low granules giving smooth covering, peripheral granules reduced not distinctive, centrals larger than peripherals, limits of plates distinct to naked eye. Marginal plates distinct, granules of similar size to each other, close but not compact, distinctly smaller than those on actinal or abactinal surfaces. Actinal plates up to 6 rows proximally. Furrow spines 2-4. Subambulacral spines 3-4 on first row and 2-3 on second row. Papulae numerous dorsally extending almost to arm tips, absent intermarginally and actinally. Pedicellariae absent. Colour red or orange according to Clark (1946), or pale pink to pale orange-pink (L. M. Marsh, pers. comm.).

Remarks: The form and granulation of the tabulae (Fig. 4a), the distribution of the papulae, the fine granulation of the marginal plates and the relationship of R/r gives this species a particularly characteristic appearance. The relationship of this species with extreme forms of *N. ocellata* from the Great Australian Bight are discussed under that species.

On the basis of a poorly preserved specimen (WAM; 9676, R/r = 35/14 mm) from Bald I., near Albany, W.A. in 51.2-64 m, which we recognise as *ocellifera*, we extend the range of the species to the south coast of W.A., otherwise all known specimens have been collected between Geraldton and Cape Naturaliste, W.A., in depths of 45-180 m. The specimen from Bald I. was identified by Shepherd (1967) as *N. ocellata*.

Distribution: Geraldton to Bald I., near Albany, W.A.; 45-180 m (Fig. 3a).

Nectria ocellata Perrier
(Figs 2a & 4b-8a)

Asterias ocellifera Lamarck, 1816: 553 (part); 1840: 239 (part).

Nectria oculifera (lapsus cal. for *ocellifera*): Gray, 1840: 287.

Nectria ocellifera: Gray, 1866: 15; Sladen, 1889: 319, pl. 55, figs 1-7; H. L. Clark, 1909: 529.

Nectria ocellata: Perrier, 1875: 188; 1876: 4; H. L. Clark, 1916: 34; 1928: 378 (part), 379 (key); 1938: 78; 1946: 85; Cotton & Godfrey, 1942: 197 (part); A. M. Clark, 1966: 313, 315 (table-part), pl. 2, fig. 3; Shepherd, 1967: 468 (part), fig. 4; 1968: 738 (part); Marsh, 1976: 217 (table); Zeidler & Shepherd, 1982: 406 (part); fig. 10.4a.

Nectria multispina: Shepherd 1967: 468 (part).

Material Examined: Lectotype (designated herein), BMNH; 1958: 7.30.20 (R/r = 68/23 mm), Tasmania, purchased E. Gerrard jun. One specimen BMNH, 1953; 4.27.24 (R/r = 53-56/16 mm), without data.

In addition 98 specimens from AM, 38 specimens from MV, 36 specimens from TM, 18 specimens from

SAM, 15 specimens from MCZ, 7 specimens from QVM and 4 specimens from WAM.

Diagnosis: R up to 125 mm, r up to 45 mm. $R/r = 2.97 \pm 0.05$ ($\pm 95\%$ c.l.). Tabulae with central granules of similar size and shape, close but usually not compact, rounded to angular in cross-section, rarely lower than peripherals. Peripheral granules of similar size to each other, usually smaller than centrals, wedge-shaped, forming more or less compact ring around centrals, tending to radiate in some specimens. Tabulae varying from flat to convex, extending beyond disc to about ⅔ R. Dorsal arm plates usually convex sometimes flat, decreasing regularly in size towards arm tip, peripheral granules becoming indistinct, central granules often enlarged and prominent giving plates rough appearance, limits of plates varying from distinct to indistinct to naked eye. Marginal plates distinct, granules of similar size to each other, convex, close but not compact, similar to those on actinal surface. Actinal plates up to 8 rows proximally. Furrow spines 2-4 (rarely 5). Subambulacral spines 1-3 on first and second row. Papulae numerous dorsally extending almost to arm tips, absent intermarginally and actinally. Pedicellariae with 3-4 (rarely 2 or 5) usually elongate valves (Fig. 2a), common on all surfaces, frequently replacing subambulacral spines. Colour uniformly brick red to orange, sometimes mottled with lighter and darker coloured tabulae.

Remarks: This is the most variable and frequently mis-identified species of *Nectria*. This has been so since Gray (1840) originally mis-identified the species as *ocellifera* Lamarck. Perrier (1875) examined a number of specimens in the BMNH, all apparently from northern Tas. and concluded that Gray mis-identified *ocellifera* of Lamarck and proposed the name *ocellata*. We have examined 3 historical specimens each of which was possibly examined by Gray and subsequently Perrier (A. M. Clark, pers. comm.), of these one specimen (BMNH; 1846.8.3.14) we identify as *N. pedicelligera* (Fig. 9a) (see p. 000), of the other two, one (BMNH; 1958.7.30.20) has tabulae and tabular granulation conforming closely to Perrier's description and this specimen we nominate as a lectotype for the species *ocellata* (Fig. 4b). We have rejected the second specimen (BMNH; 1953.4.27.24) (Fig. 6b) as a possible lectotype or paralectotype, even though Perrier probably saw it, as the tabulae and tabular granulation does not conform to Perrier's description of *N. ocellata*, and we are therefore uncertain that it qualifies as a type specimen. Perrier (1875) also refers to a poor specimen in the MNHN which he was unable to determine. This specimen (ECAS 668) which may have been seen by Lamarck and identified as *ocellifera* has been labelled as a type of *ocellata* which it clearly is not as the species description of *ocellata* was based on the material in the BMNH.

Following our examination of 218 specimens from southern and south-eastern Australia we have recognised 3 more or less intergrading forms within the species *ocellata*.

The first form conforms most closely with the lectotype in that the tabulae are slightly convex and covered with even sized granules (Figs 5a, b). This form has its centre of distribution at the eastern and north coast of Tas. extending north to Port Jackson, N.S.W. and west to Phillip I. Vic. and is found in very shallow water from the shoreline down to 20 m (Fig. 3b).

Along the east coast of Australia we recognise a second form with tabulae with central granules which become shorter than the peripheral granules, the latter radiating giving the tabula a flatter appearance and with dorsal arm plates which frequently possess enlarged central granules giving the arms a rough texture (Figs 5c, 6a) similar to that of *wilsoni* from W.A. This form is distributed between Broughton I., off Port Stephens, N.S.W. and Erith I., Bass Strait, but has a greater depth range than form 1 occurring in 0-90 m (Fig. 3b).

The third form (Figs 6b-d; 7a) has tabulae with central granules distinctly shorter than the radiating peripherals, becoming flattened and *ocellifera*-like at the extreme western end of their range (Figs 7b; 8a). The dorsal arm plates have an even covering of granules and the limits of the plates are relatively distinct. We do not identify the specimens from the Great Australian Bight with *ocellifera* because of the elongate arms and the smaller size and distribution of the tabulae despite the fact that the marginal granulation is finer than the actinal granulation. These extreme variants may point to a relationship between *ocellata* and *ocellifera* which is not obvious when comparing *ocellifera* from W.A. (Fig. 4a) with typical *ocellata* from Tas. (Fig. 5a). The relationship between *ocellata* and *ocellifera* can only be resolved satisfactorily when more specimens from the Great Australian Bight become available.

Form 3 extends from south-eastern Tas. west to the Great Australian Bight (125°30'E) occurring in depths of 5-230 m (Fig. 3b).

Although form 1 clearly intergrades with form 2 along the east coast and with form 3 along the south coast, forms 2 and 3 are easily separable and may have originated as a result of the Pleistocene land bridge between Vic. and Tas. separating the two populations which then developed their different characteristics.

Along the NSW coast, at least as far south as Eden, *N. ocellata* is the only known species of *Nectria* so that its identity has not been confused. However, along the south coast the species most often confused with *ocellata* is *pedicelligera* (Figs 9b; 10a) which most resembles our form 3 and can most easily be distinguished from it by the presence of intermarginal papulae.

Of the first 13 records of *ocellata* listed by Clark (1966, table 3) at least two (BMNH; 1862.7.9.51 and -52) from W.A. and Dirk Hartog I. (Shark Bay, W.A.)

respectively are unlikely to be *ocellata*. Further we doubt the likelihood of Dirk Hartog I. as a locality from which *Nectria* would have been collected.

Shepherd (1967) records a juvenile specimen from Caloundra, Queensland; we have examined this specimen and confirm its identity but consider the locality data to be erroneous.

Distribution: Western end of the Great Australian Bight (125°30'E) through Bass Strait south along the eastern coast of Tas. and north along the N.S.W. coast to Broughton I.; intertidal to 230 m (Fig. 3b).

Nectria macrobrachia H. L. Clark
(Figs 2b & 8b, c)

Nectria macrobrachia H. L. Clark, 1923: 236, pl. 13, figs 5-6; 1928: 379 (key); 1946: 86; A. M. Clark, 1966: 311, pl. 3, figs 2-3, text fig. 2; Shepherd, 1967: 474, fig. 2 (part); 1968: 738; Marsh, 1976: 217 (table); Zeidler & Shepherd, 1982: 406, fig. 10.4e.

Material Examined: Holotype, BMNH, 1929: 6.12.1 (R/r = 60/17 mm), Pelsart Group, Houtman Abrolhos, shore, Prof. Dakin.

In addition 32 specimens from WAM, 23 specimens from SAM and 20 specimens from A.M.

Diagnosis: R up to 75 mm, r up to 21 mm. R/r = 3.47 ± 0.08 (±95% c.l.). Tabulae with central granules irregular in size and shape, flat, low in profile, close but not compact, angular in cross-section. Peripheral granules of similar size to each other, conspicuously larger than centrals, sometimes radiating particularly in deep-water specimens (Fig. 8c), generally wedge-shaped, raised well above centrals to form concave tabulae. Tabulae low, crowded extending beyond disc to about ⅓ R. Dorsal arm plates flat, decreasing regularly in size towards arm tips, peripheral granules becoming indistinct from centrals, limits of plates indistinct to naked eye. Marginal plates relatively indistinct due to close, even covering of granules, similar to those on actinal surface. Actinal plates up to 3 (rarely 4) rows proximally. Furrow spines 2-3. Subambulacral spines 2-3 in first and second row. Papulae numerous dorsally extending to arm tips also present intermarginally and actinally. Pedicellariae with 3-4 broad valves (Fig. 2b) resembling those of *N. multispina*, rarely present, occurring at least on actinal and abactinal surface. Colour light yellow to orange, brown or even pink with peripheral granules on tabulae lighter and arm tips darker than rest of body (Shepherd 1967).

Remarks: The form and granulation of the tabulae (Figs 8b, c) and the distribution of the papulae easily separates this species from others in the genus.

Distribution: Houtman Abrolhos, W.A. to Wilson's Promontory, Vic. and Erith I., Bass Strait, but has not been recorded from Tas.; intertial to 180 m (Fig. 3c). We have been unable to substantiate the depth record of 350 m given by Shepherd (1967) which we consider to be a misprint.

Nectria pedicelligera Mortensen
(Figs 2c, 9 & 10a, b)

?Chaetaster munitus, Möbius, 1859: 3, pl. 1, figs 1-2.
Nectria sp. Fisher, 1911: 163; H. L. Clark, 1914: 140.
Nectria pedicelligera Mortensen, 1925: 291, pl. 13, figs 5-6, text fig. 9; H. L. Clark, 1928: 370 (key); A. M. Clark, 1966: 315 (table); Shepherd, 1967: 478.
Nectria ocellata: H. L. Clark, 1928: 378, 379 (key); A. M. Clark, 1966: 315 (table-part), pl. 2, fig. 4; Shepherd, 1967: 465 (part); Zeidler & Shepherd, 1982: 406 (part); fig. 10.4b.
Nectria multispina: Cotton & Godfrey, 1942: 197; A. M. Clark, 1966: 314 (part); Shepherd, 1967: 468 (part), fig. 3 (part).

Material Examined: Holotype, Otago Museum; A 53-47 (R/r = 53/18 mm), Gisborne, east coast North I., New Zealand, H. Suter? (see remarks). One specimen, BMNH; 1846: 8.3.14 (R/r = 55/18 mm), Flinders I., Tasmania, Lord Stanley.

In addition 146 specimens from SAM, 26 specimens from MV, 25 specimens from AM, 11 specimens from WAM, 4 specimens from MCZ and 2 specimens from TM and QVM.

Diagnosis: R up to 120 mm, r up to 36 mm. R/r = 3.16 ± 0.04 (±95% c.l.). Tabulae with central granules of similar size and shape, close or compact, angular in cross-section, larger than peripherals. Peripheral granules of similar size to each other, wedge-shaped, forming a more or less compact ring around centrals, rarely radiating. Tabulae slightly convex, rarely flat, extending beyond disc for up to ½ R. Dorsal arm plates more or less flat, decreasing regularly in size towards arm tip, peripheral granules becoming indistinct, central granules similar to peripherals or enlarged and prominent giving plates rough appearance, limits of plates indistinct to naked eye. Marginal plates distinct, granules of similar size to each other, convex, close but not compact, coarse, similar to those on actinal surface. Actinal plates up to 7 rows proximally, coarsely granulated. Furrow spines 3-4 (sometimes 5, rarely 6). Subambulacral spines 2-3 on first row and 3-4 (rarely up to 6) on second row. Papulae numerous dorsally extending almost to arm tips, also present intermarginally but rarely actinally. Pedicellariae with 3-5 (rarely 6) very slender valves (Fig. 2c), valves particularly slender on actinal surface, usually common on all surfaces and often replacing a subambulacral spine on the adambulacral plates. Colour uniformly brick red to orange, often mottled with lighter coloured tabulae, especially at the base of the arms.

Remarks: This is the first time that this species has been fully recognised since Mortensen (1925) described it, from Gisborne, New Zealand. However, according to A. N. Baker (pers. comm.), despite extensive collecting efforts in New Zealand particularly off Gisborne, no species of *Nectria* have ever been

recovered. We therefore believe the New Zealand record to be an error and we recognise it as an endemic southern Australian species. This species is now known to range from Denmark, W.A. to Eden, N.S.W. including the north coast of Tas. and is a shallow-water species occurring in 0-20 m.

This species has been confused most frequently with *ocellata* and *multispina*. This confusion has probably arisen because previous authors have not examined the type of *pedicelligera* thus not appreciating it as a southern Australian species believing it to be endemic to New Zealand. *N. pedicelligera* is distinguished from *ocellata* by the intermarginal papulae, often the presence of a rosette of 6 prominent tabulae at the base of the arms and the more regular form of the granulation (Figs 9a, c; 10a). Superficially it resembles some specimens of *multispina* (Fig. 10b) however, *multispina* differs in the form of its granulation, the enlarged plates extending along the arm, the consistently higher number of furrow spines and the much broader valved pedicellariae.

We have examined the specimen from Westernport, Vic. (MCZ, 1932), described by Fisher (1911) and examined by Clark (1914) and have identified it as *pedicelligera*. The holotype of *Chaetaster munitus* Möbius 1859 is presumed lost as it is not in the Kiel museum (Shepherd 1967) and was not found by one of us (F.W.E.R.) in the Hamburg museum. However, the figure given by Möbius (1859) is most like *pedicelligera*, particularly in the arrangement of the tabulae and their granulation. The apparent absence of pedicellariae with large valves on the actinal surface also excludes it from *multispina* with which Clark (1966) and Shepherd (1967) thought it was conspecific. In order to maintain stability and due to the inadequate description given by Möbius and the loss of type material we agree with Clark (1966) that the name *Chaetaster munitus* be treated as a nomen oblitum, such action however requires a case to be put to the ICZN (article 23b).

The three specimens (BMNH; 1862.1.8.10 & 11; 1846.8.3.14) recorded by A. M. Clark from Tas. (1966, table 3) as "intermediate between *ocellata* and *multispina*" we identify as *pedicelligera*.

Distribution: Denmark, W.A. to Eden, N.S.W. including Bass Strait and the north-west of Tas.; intertidal to 20 m (Fig. 3d).

Nectria multispina H. L. Clark
(Figs 2d, 10c & 11a)

Nectria multispina H. L. Clark, 1928: 375, figs 111a-b; 1938: 77, 1946: 86; Cotton & Godfrey, 1942: 197 (part); A. M. Clark, 1966: 314, 315 (table-part), pl. 2, figs 1-2; Shepherd, 1967: 468 (part); 1968: 739; Marsh, 1976: 217 (table); Zeidler & Shepherd, 1982: 406, figs 10.4c, d.

Material Examined: Holotype, SAM; K50 (R/r = 80-85/30-32 mm)? S.A., probably Spencer Gulf or Gulf St Vincent, H. L. Clark (1928); 2 paratypes, SAM; K52 (R/r = 56/19, 51/17 mm) without locality data, J. C. Verco Feb 1891; paratype, MCZ 2904 (R/r = 60/19 mm) with same data as K52.

In addition 22 specimens from SAM, 7 specimens from AM, 4 specimens from WAM and one specimen from MV.

Diagnosis: R up to 102 mm, r up to 34 mm. R/r = 3.01 ± 0.08 (±95% c.l.). Tabulae with central granules irregular in size with central ones being larger than those at periphery, very compact giving central tabulae smooth convex appearance, angular in cross-section, all larger than peripherals. Peripheral granules of similar size to each other forming distinct compact ring around centrals. Tabulae appear to extend to arm tips but from ⅔ R become indistinguishable from convex plates, interspersed with smaller, flatter plates. Dorsal arm plates with granules maintaining their relative sizes but peripherals becoming less distinct than on disc, limits of plates distinct to naked eye. Marginal plates distinct, granules often similar in size, sometimes the peripherals are noticeably smaller, close, sometimes compact, similar in size to those on actinal surface. Actinal plates up to 6 rows proximally. Furrow spines 4-6 (rarely 3 or 7). Subambulacral spines 3 (rarely 4) in first row, 3-8 in second row. Papulae numerous dorsally, extending to arm tips, also present intermarginally, absent actinally. Pedicellariae with 3-4 (rarely 2) distinctive broad valves (Fig. 2d), common on all surfaces but particularly characteristic of first actinal row of plates. Colour orange to brick red, mottled with darker tabulae, often only some of the central granules of the tabulae are darker.

Remarks: This is a clearly defined species easily distinguished by the form of the tabulae, the distinctive pedicellariae and the consistently high number of furrow spines (Figs 10c; 11a). Although *multispina* has not been confused with other species it is clear that other species have been confused with *multispina* due to a lack of understanding of the limits of each of the species of *Nectria*. *N. ocellata* and *N. pedicelligera* have been the species most frequently confused with *multispina* and this is discussed under those species.

Of the 9 lots of specimens referred to *multispina* by Clark (1966, table 3) only the type specimens and specimens under the number BMNH; 1962.4.97 are *multispina*.

The species which most resembles and appears most closely related to *multispina* is *saoria*, particularly in the arrangement of the tabulae and dorsal arm plates. However it is clearly distinguished by its smaller disc, the consistently fewer furrow spines and the absence of the characteristically large pedicellariae found in *multispina*.

Distribution: Shoalwater Bay, near Cape Peron, south of Fremantle, W.A. to Wilson's Promontory, Vic.

but not from Bass Strait or Tas., intertidal to 20 m (Fig. 3a).

Nectria wilsoni Shepherd & Hodgkin
(Figs 2e, 11b & 12)

Nectria wilsoni Shepherd & Hodgkin, 1965: 119, fig. 1; Shepherd, 1967: 474; Marsh, 1976: 217 (table); Zeidler & Shepherd, 1982: 408, fig. 10.4e.

Nectria ocellata: A. M. Clark, 1966: 315 (table-part), pl. 1, figs 4-6; Shepherd, 1967: 465 (part).

Material Examined: Holotype, WAM; 3-65 (R/r = 77/26 mm), Sorrento Beach, W.A. 1.8 m, B. R. Wilson, 27. I.1963; paratype, WAM; 18-59 (R/r = 63/20 mm), Eagle Bay, Cape Naturaliste, W.A., 9.2 m, B. R. Wilson & L. Marsh, 27.XII.1958; paratype, WAM; 19-59 (R/r = 75/25 mm), Dunsborough, W.A., 9.2 m, B. R. Wilson & L. Marsh, 25.XII.1958; paratype, WAM; 2-62 (R/r = 88/31 mm), Hamelin Bay near Cape Leeuwin, W.A., on jetty piles, B. R. Wilson & R. Slack-Smith, 30.XII.1961; paratype, WAM, 1-65 (R/r = 56/19 mm), Dunsborough, W.A., 16.9 m on rock, B. R. Wilson, 15.IV.1963; paratype, WAM; 2-65 (R/r = 90/34 mm) Sorrento Reef near Fremantle, W.A., on sea grass, B. R. Wilson; paratype, WAM; 4-65 (R/r = 90/30 mm) Sorrento Reef, W.A., B. R. Wilson, 21.XII. 1963; paratype, WAM; 5-65 (R/r = 83/27 mm) Sorrento beach, W.A., 5.5.m on sea grass near limestone, B. R. Wilson, 23.XI. 1963; paratype, WAM; 3-62 (R/r = 120/45 mm), off Beagle Island (29°50'S), W.A., Poole Brothers, Mar. 1961; paratype, SAM; K613 (R/r = 69/22 mm) Hall Bank near Fremantle, W.A., B. R. Wilson, 1.II.1963.

In addition 40 specimens from WAM, 9 specimens from SAM and 7 specimens from AM.

Diagnosis: R up to 120 mm, r up to 40 mm. R/r = 3.08 ± 0.06 (±95% c.l.). Tabulae with central granules irregular in size and shape, a mixture of granules larger and smaller than peripherals, markedly convex, raised well above tabula, well spaced (rarely crowded), round in cross-section. Peripheral granules radiating, irregular in size and shape, but forming distinct peripheral ring. Tabulae more or less confined to disc. Dorsal arm plates, flat decreasing in size towards arm tip, with very coarse granulation, 1 or 2 central granules on each plate often enlarged and prominent, limits of plates indistinct to naked eye. Marginal plates distinct, granules coarse, spaced, some central ones very large similar to dorsal arm plates. Actinal plates up to 7-8 rows proximally. Furrow spines 3-4 (rarely 2). Subambulacral spines 2-3 on first and second row. Papulae numerous dorsally extending rarely beyond ½ R, absent intermarginally and actinally. Pedicellariae with 4-5 (rarely 3, 6 or 7) slender valves (Fig. 2e), usually present on all surfaces, some specimens without.

Colour deep orange to magenta, papular area lighter (Shepherd and Hodgkin 1965).

Remarks: Despite some confusion between this species and *ocellata* the large and irregular granules of the tabulae, marginals and arm plates particularly make *wilsoni* a very distinctive species (Fig. 11b). The granulation of this species is very variable (Fig. 12). It is interesting to note that some N.S.W. specimens of *ocellata* (Fig. 6a) resemble *wilsoni* in that the granules become irregular. However, the tabular granulation is much finer and the granules are more numerous in the N.S.W. specimens so that these two widely geographically separated species are not confused. We agree with Shepherd (1967) that the three specimens (WAM; 18.59; 19.59 & 2.62) recorded by Clark (1966, table 3) as being "affiliated to *ocellata*" are *wilsoni*. The species is now extended in range eastward across the Great Australian Bight to Cape Jervis, S.A.

Distribution: Beagle I., W.A. to Cape Jervis, S.A.; intertidal to 44 m (Fig. 3f).

Nectria saoria Shepherd
(Figs 2f & 13a)

Nectria saoria Shepherd, 1967: 475, fig. 2 (part); 1968: 739; Marsh, 1976: 217 (table); Zeidler & Shepherd, 1982: 408, fig. 10.4.f.

Nectria multispina: A. M. Clark, 1966: 315 (table-part).

Material Examined: Holotype, SAM; K670 (R/r = 56/15 mm), submerged limestone reef between Wright I. and The Bluff, Encounter Bay, S.A., 10 m, S. A. Shepherd, 8.VI.1963; 4 paratypes, SAM; K628 (R/r = 56/15, 53/16, 50/13, 47/14 mm), collected with type; 3 paratypes, SAM; K627 (R/r = 61/16, 52/15, 40/13 mm), West I., Encounter Bay, S.A., 10 m, S. A. Shepherd, 23.VIII.1964; paratype, SAM; K656 (R/r = 65/17 mm) collected with type; paratype, SAM; K658 (R/r = 64/20 mm), limestone reef between Thistle and Hopkins I., Spencer Gulf, S.A., 10 m., S. A. Shepherd, Jan. 1964; paratype, WAM 8-64 (R/r = 60/17 mm), Hamelin Bay near Cape Leeuwin, W.A., B. R. Wilson and R. Slack-Smith, 30.XII.61.

In addition 24 specimens from SAM, 23 specimens from WAM, 7 specimens from MV and 6 specimens from AM.

Diagnosis: R up to 83 mm, r up to 28 mm. R/r = 3.49 ± 0.09 (±95% c.l.). Tabulae with central granules similar in size, sometimes 1-2 very large granules but these usually mixed with smaller ones, compact giving tabulae convex appearance, angular in cross-section, all larger than peripherals. Peripheral granules slightly irregular in size forming an irregular peripheral ring. Tabulae appear to extend to arm tips but from about ⅔ R become indistinguishable from convex plates; interspersed with smaller plates. Dorsal arm plates with granulation similar to disc but more compact giving the larger distal plates a smoother aspect, limits of plates distinct to naked eye. Marginal plates distinct, granules often similar in size to each other, close, sometimes compact, similar in size to those

on actinal surface. Actinal plates up to 2-3 rows proximally. Furrow spines 3-4 (rarely 2). Subambulacral spines 2-3 in first row, 2-4 in second row. Papulae numerous dorsally, extending to arm tips, less common and sometimes absent intermarginally, absent actinally. Pedicellariae with 3-5 (rarely 2 or 6) elongate valves (Fig. 2f), common abactinally, less common or absent marginally and actinally. Colour bright red, papulae black (Shepherd 1967).

Remarks: This distinctive species (Fig. 13a) has been adequately described by Shepherd (1967) and its relationship to *multispina* has been discussed under that species. Prior to Shepherd's description of this species it has been identified with *multispina*.

Of the 9 lots of specimens referred to *multispina* by Clark (1966, table 3) those from Rottnest I., Albany and Recherche Archipelago are *saoria* as suggested by Shepherd (1967).

Distribution: Off Perth and Rottnest I., W.A. to Encounter Bay, S.A. intertidal to 25 m (Fig. 3g).

Nectria humilis sp.nov.
(Figs 2g; 13b & 14)

Material Examined: Holotype, TM; H 1476, 80 km west of Woolnorth, north-west Tas., 550 m, A. McGifford ("Sea Fisheries"), 28.II.1979; paratype, TM; H 1844, collected with holotype; 7 paratypes, AM; J 18467, labelled "80/130 off Storm Bay near Tamar River 25-30 fms" (approx. 45-55 m), no other data.

Description: The holotype (Fig. 13b) measures R/r = 53-58/17.5 mm; br = 22 mm. Arms taper regularly to narrow tip. Abactinal tabulae low not more than 1 mm high, very slightly convex, longitudinally ovate up to 3.5 × 2.9 mm, spaced, arranged in a carinal row with two dorsal lateral rows to about ½ R, a third dorsal row of plates also extends to about ½ R, beyond ½ R the tabulae become indistinguishable from arm plates, tabulae/arm plates decrease regularly in size distally. Tabulae with central granules of even size, convex, low, angular in cross-section, peripheral granules marginally smaller than centrals forming compact ring around centrals. Marginal plates distinct, 22-23 supero- and infero-marginal plates with an even covering of small granules (approx. 7 granules/2 mm), finer than those on actinal plates. Actinal plates of 6 rows proximally, the first row extends almost to arm tip (to 17th infero-marginal plate) the second, third and fourth row extend to the 5th, 3rd and 2nd infero-marginal plates respectively, the fifth and sixth row do not extend beyond the 1st inferomarginal plate. Actinal plates covered with coarse, spaced granules (approx. 5 granules/2 mm). Adambulacral plates with 3-4 furrow spines, where there are 4 the first one is smallest otherwise the other 3 are similar in size to each other. Subambulacral spines, 3 on first row, about half-length of furrow spines; 3 on second row, barely indistinguishable in size from adjacent actinal granulation. Oral plates with 8 furrow-spines, 4 subambulacral spines and 7-8 low spines/granules on actinal surface of plate. Papulae abundant dorsally in discrete groups of 8-10, confined by the skeletal reticulum, absent intermarginally and actinally. Pedicellariae absent. Colour unknown (white in alcohol).

The paratype (Fig. 14) (TM; H 1844) measures R/r = 46-51/17-19 mm; br = 23 mm. Essentially similar to holotype differing only in having stouter arms.

The seven paratypes (AM; J 18467) range in size from R/r = 66/18 mm to R/r = 48/25.5 mm and differ from the type only in the presence of pedicellariae which occur on the dorsal and actinal surfaces, but are most common on the adambulacral plates. Pedicellariae with 3-4 valves, triangular in shape, about twice as long as wide (Fig. 2g).

Etymology

From the Latin *Humilis* = low, referring to the very low tabulae.

Remarks: This species stands apart from other species of *Nectria* by the granulation and form and arrangement of the dorsal tabulae. The only other species with such low tabulae is *macrobrachia,* but in this species the tabulae are close-packed and transversely hexagonal or ovate, the granulation is quite distinctive and the distribution of papulae immediately separates the two species. Amongst the species in which the papulae are restricted to the dorsal surface, *humilis* is most closely related to *ocellata*. However, the tabulae of *ocellata* never become as low, or the granulation covering the tabulae as even, as in *humilis*.

It is unfortunate that the data with the 7 paratypes is ambiguous as the Tamar River is in the mid-north of Tas. and the only known Storm Bay is that near the mouth of the Derwent in south-eastern Tasmania (Fig. 3h).

CONCLUDING REMARKS

In the most recent revision of the Asteroidea, *Nectria* has been allied with *Nectriaster* in the subfamily Nectriinae of the family Gonasteridae. However, we have concluded that skeletal features, including particularly the calcified form of the interbrachial septum, show that these genera are better placed in the family Oreasteridae. We have further concluded that *Nectria,* by virtue of its abactinal tabulae, stands apart from all other genera in that family. We prefer to recognise this isolation by maintaining the status of the subfamily Nectriinae from which *Nectriaster* is excluded. All other genera within the family Oreasteridae are referred to the new subfamily Oreasterinae.

Within the genus *Nectria* we have found the presence or absence of intermarginal papulae to be a very useful and consistent character for all of the species except *saoria*. This character in combination with the form of abactinal and marginal granulation and the form

of the pedicellariae have enabled us to determine the limits of the species.

We have determined that *Nectria* is an endemic southern Australian genus and that records from Fiji (Sladen 1889), New Zealand (Mortensen 1925) and Mauritius (MV specimen) are erroneous.

Regarding the origin of the genus *Nectria* in Australia, lack of fossil material prevents us from determining its evolutionary or temporal origin. From our knowledge of the species distributions we would infer that the genus arose in south-western Australia and distributed along the south coast; this is consistent with our present knowledge of major ocean currents in southern Australia. However, only one species, *N. ocellata,* has been successful in reaching the N.S.W. coast. Considering our interpretation of the complexity of this species we conclude that the full potential for speciation in the genus *Nectria* has not yet been realised.

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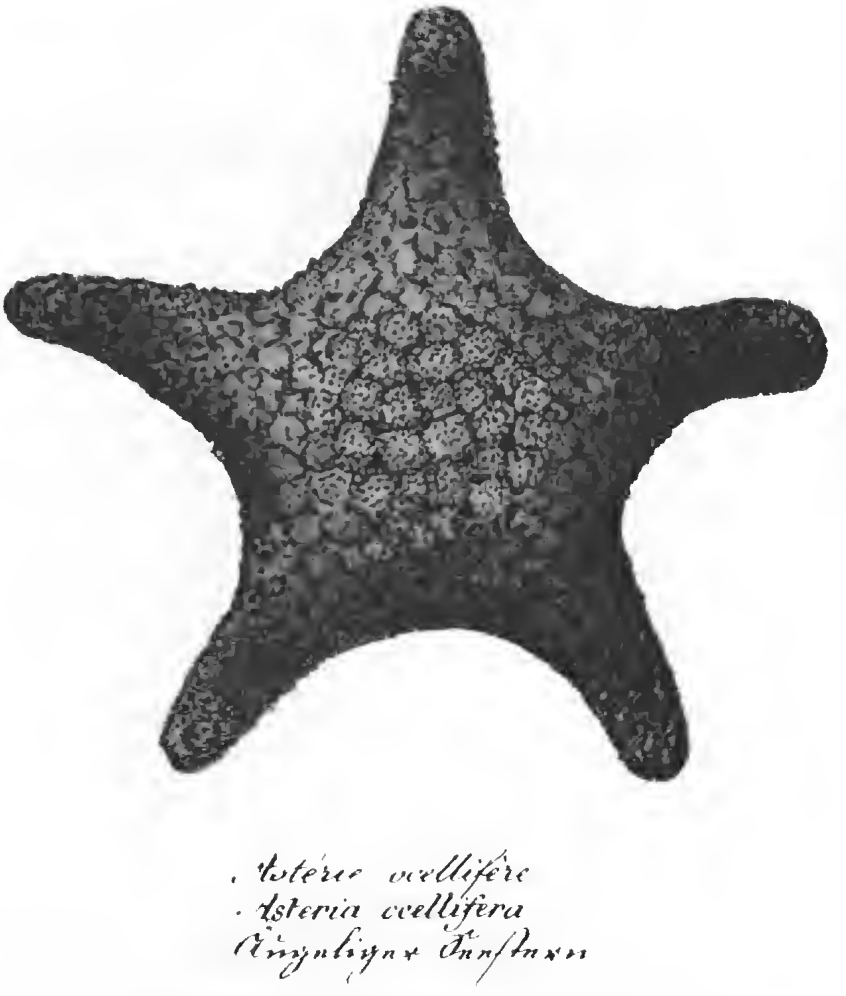

FIG. 1. Oudart's (1827) figure of *N. ocellifera* Lamarck.

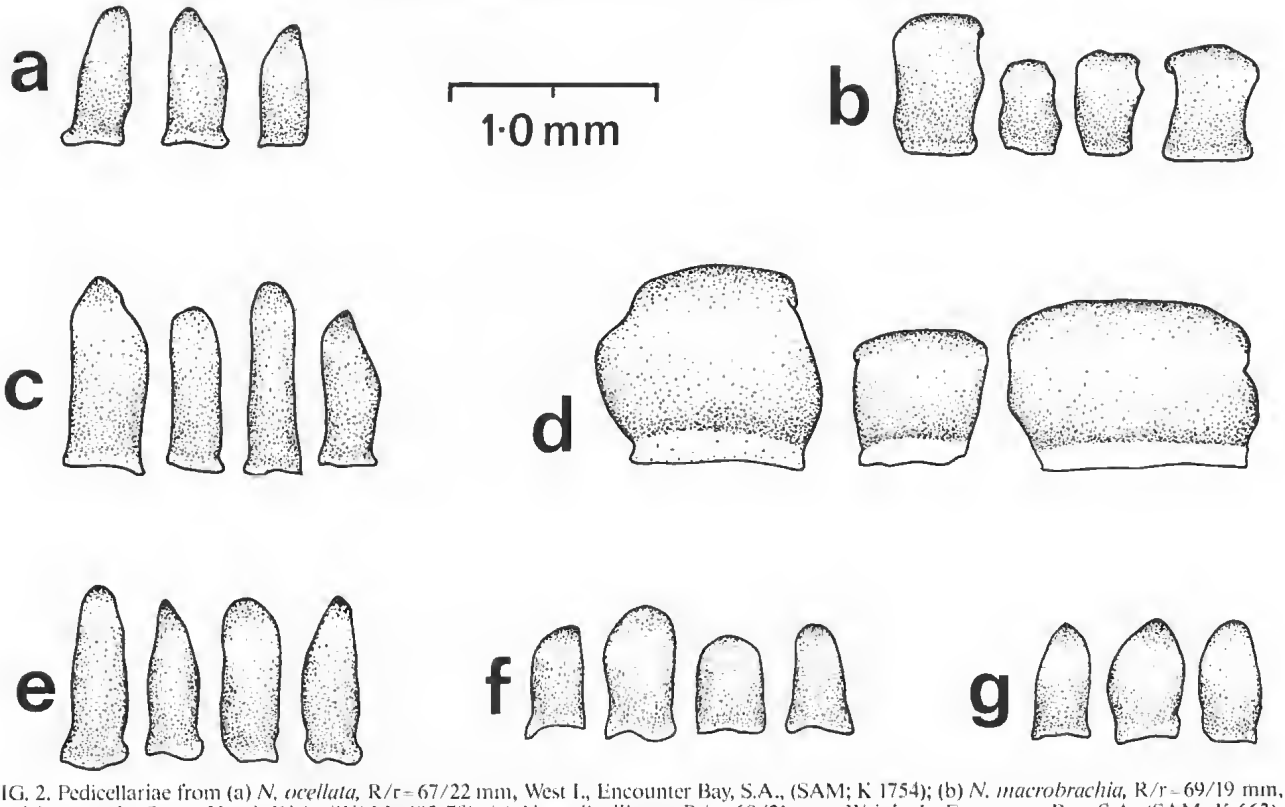

FIG. 2. Pedicellariae from (a) *N. ocellata,* R/r = 67/22 mm, West I., Encounter Bay, S.A., (SAM; K 1754); (b) *N. macrobrachia,* R/r = 69/19 mm, Fisherman I., Green Head, W.A. (WAM; 493-79); (c) *N. pedicelligera,* R/r = 69/21 mm, Wright I., Encounter Bay, S.A. (SAM; K 663); (d) *N. multispina,* R/r = 70/25 mm, Smooth I., Nuyts Archipelago, S.A. (SAM; K 1755); (e) *N. wilsoni,* R/r = 65/18 mm, St Francis I., Nuyts Archipelago, S.A. (SAM; K 1756); (f) *N saoria,* R/r = 68/19 mm, St Francis I., Nuyts Archipelago, S.A. (SAM; K 1757); (g) *N. humilis,* R/r = 64/18 mm, off Storm Bay/Tamar R., Tas., (Paratype, AM; J 18467).

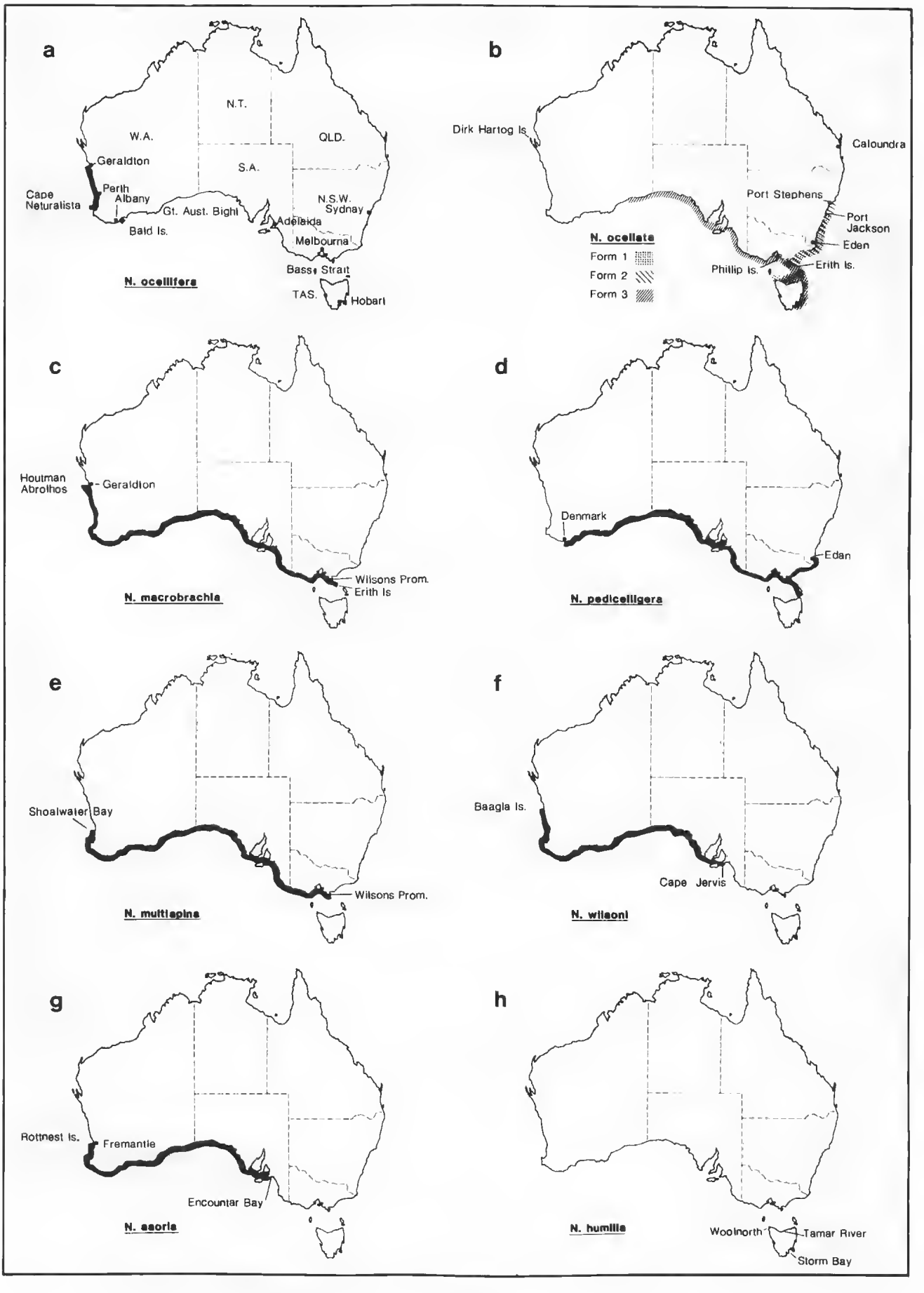

FIG. 3. Maps showing distribution of *Nectria* species.

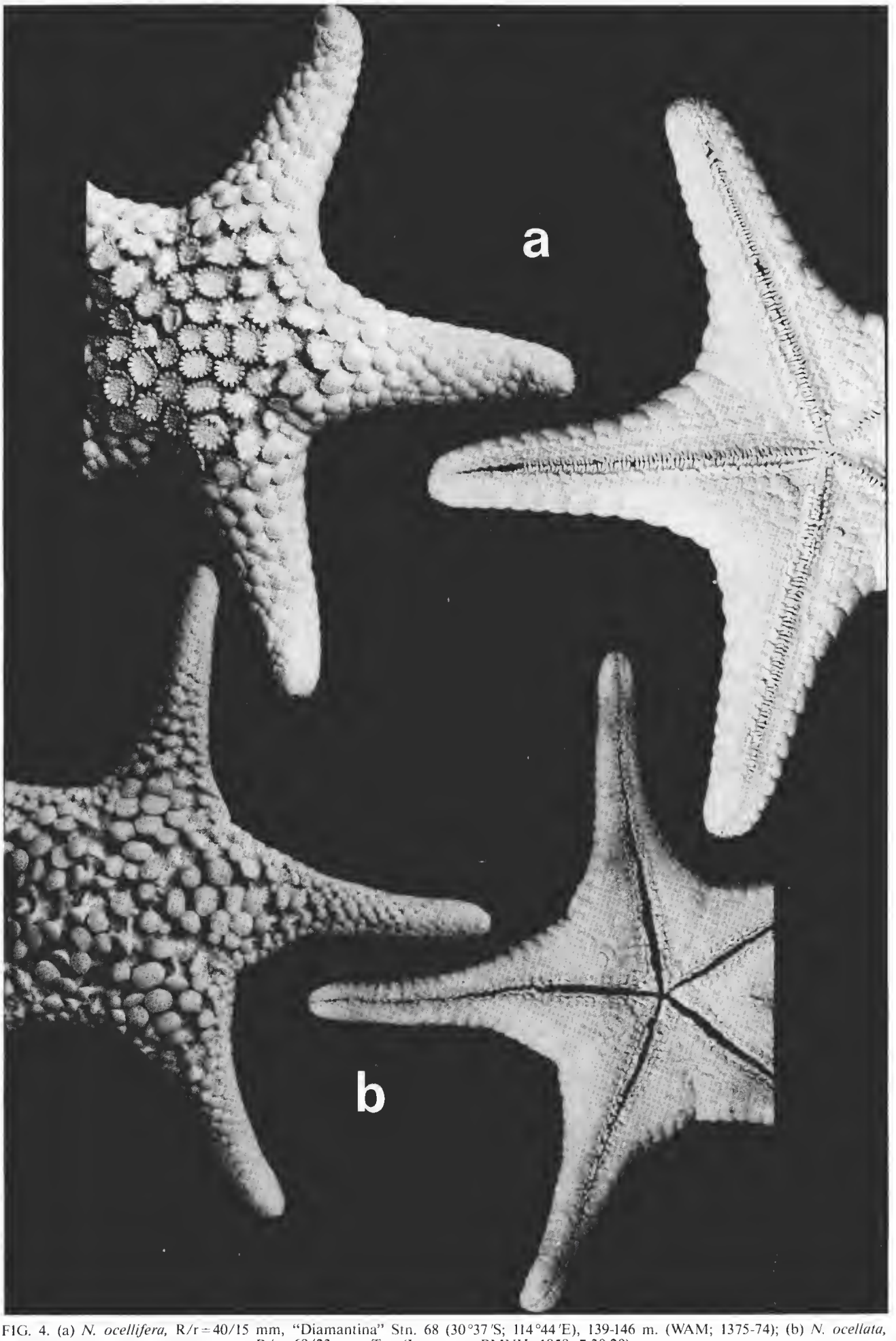

FIG. 4. (a) *N. ocellifera,* R/r = 40/15 mm, "Diamantina" Stn. 68 (30°37'S; 114°44'E), 139-146 m. (WAM; 1375-74); (b) *N. ocellata,* R/r = 68/23 mm, Tas. (Lectotype, BMNH; 1958: 7.30.20).

FIG. 5. *N. ocellata* (a) Form 1, R/r=123/40 mm, off Maria I., Tas. (TM; H 1293); (b) Form 1, R/r=76/22, Cape Woolamai, Phillip I., Vic., 10-15 mm (AM; J12499); (c) Form 2, R/r=88/29 mm, Broughton I. near Port Stephens, N.S.W., 25 m (AM; J 13003).

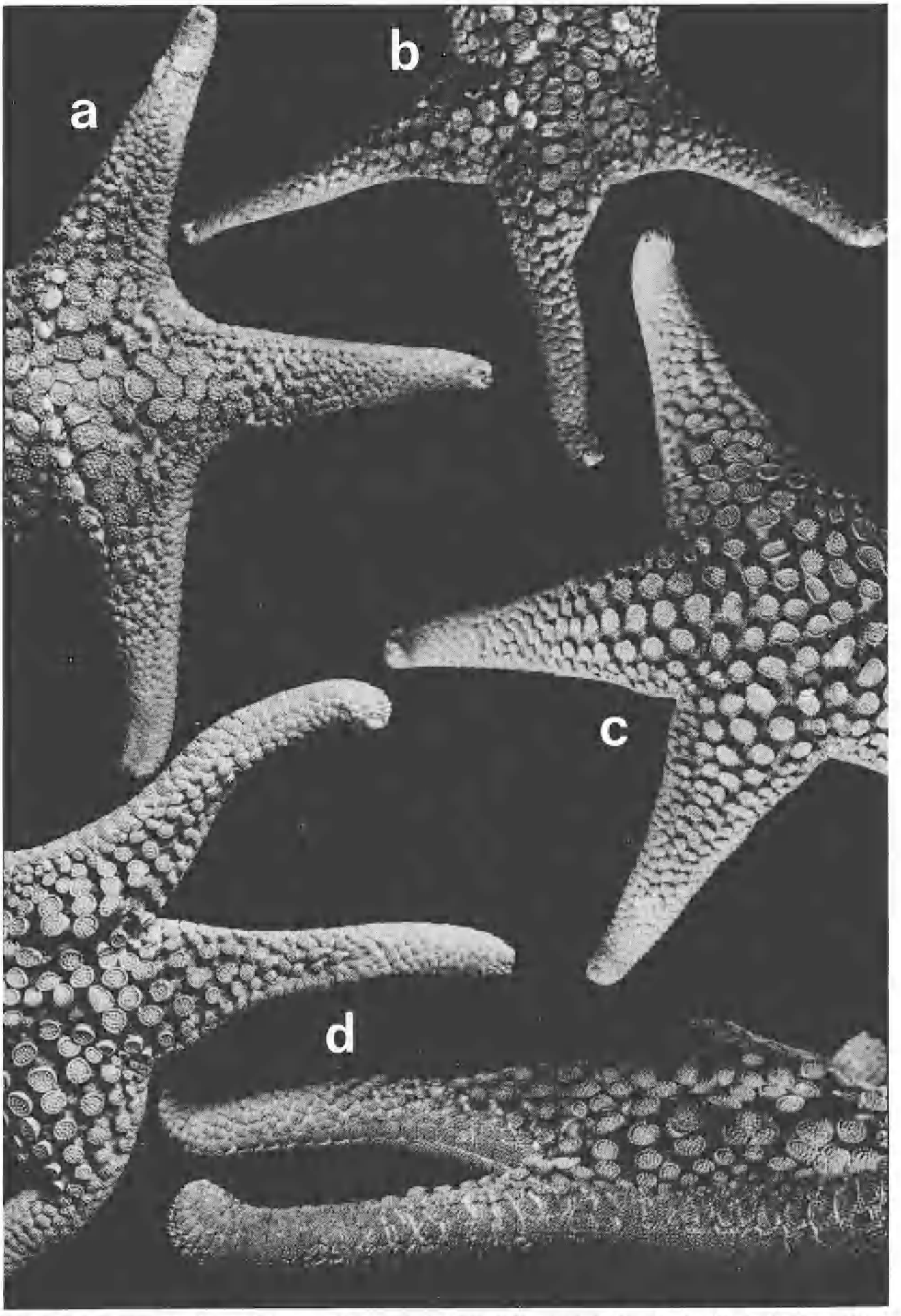

FIG. 6. *N. ocellata* (a) Form 2, R/r = 97/31 mm, off Norah Head, N.S.W., 50-70 m (AM; J 3466); (b) Form 3, R/r = 56/16 mm, without data (BMNH; 1953: 4.27.24); (c) Form 3, R/r = 87/29 mm, Westernport, North Arm Channel, Vic. (AM; J 9920); (d) Form 3, R/r = 80/27 mm, Great Taylors Bay, Bruny I., Tas. (TM; H 450).

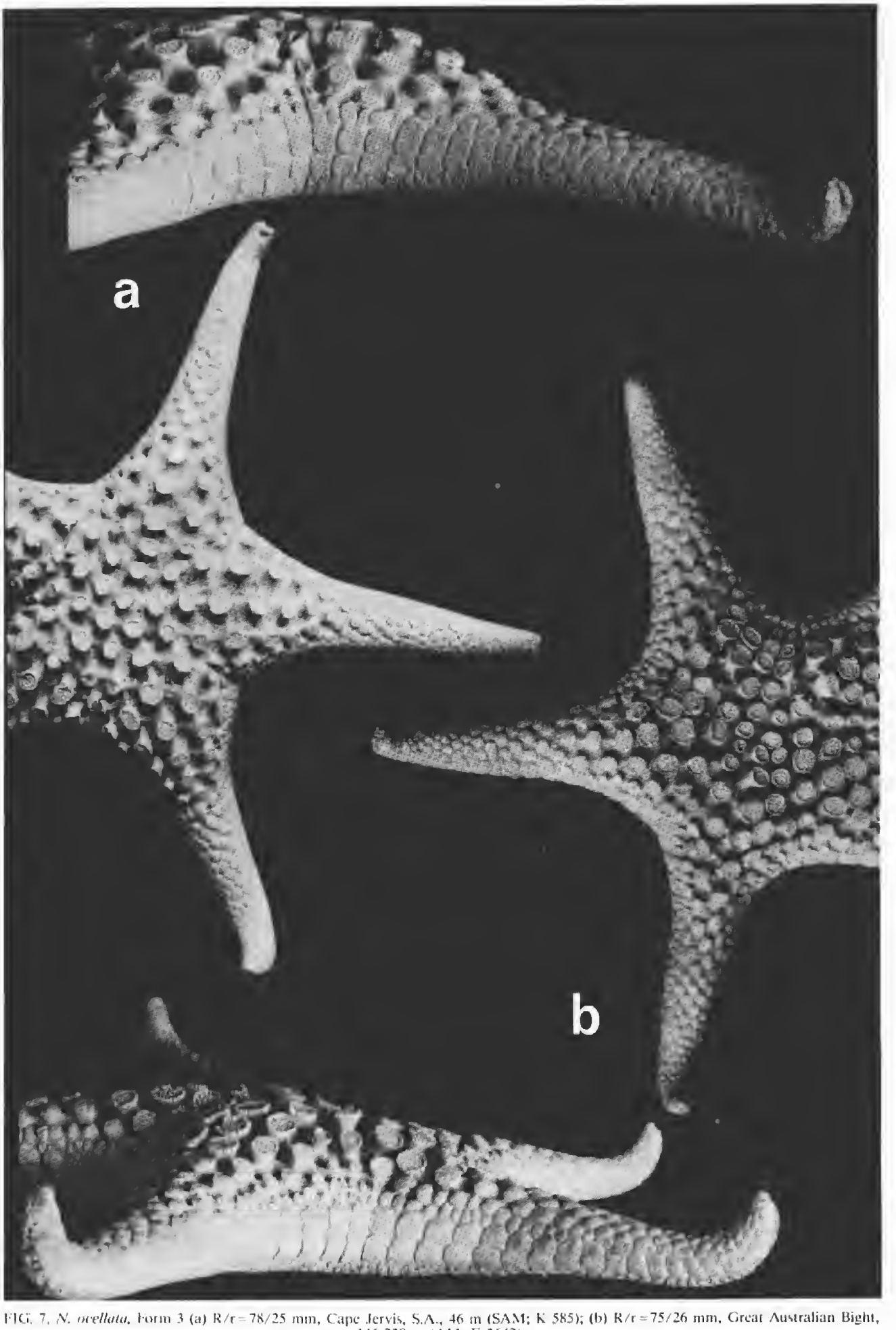

FIG. 7. *N. ocellata*, Form 3 (a) R/r = 78/25 mm, Cape Jervis, S.A., 46 m (SAM; K 585); (b) R/r = 75/26 mm, Great Australian Bight, 146-230 m (AM; E 3642).

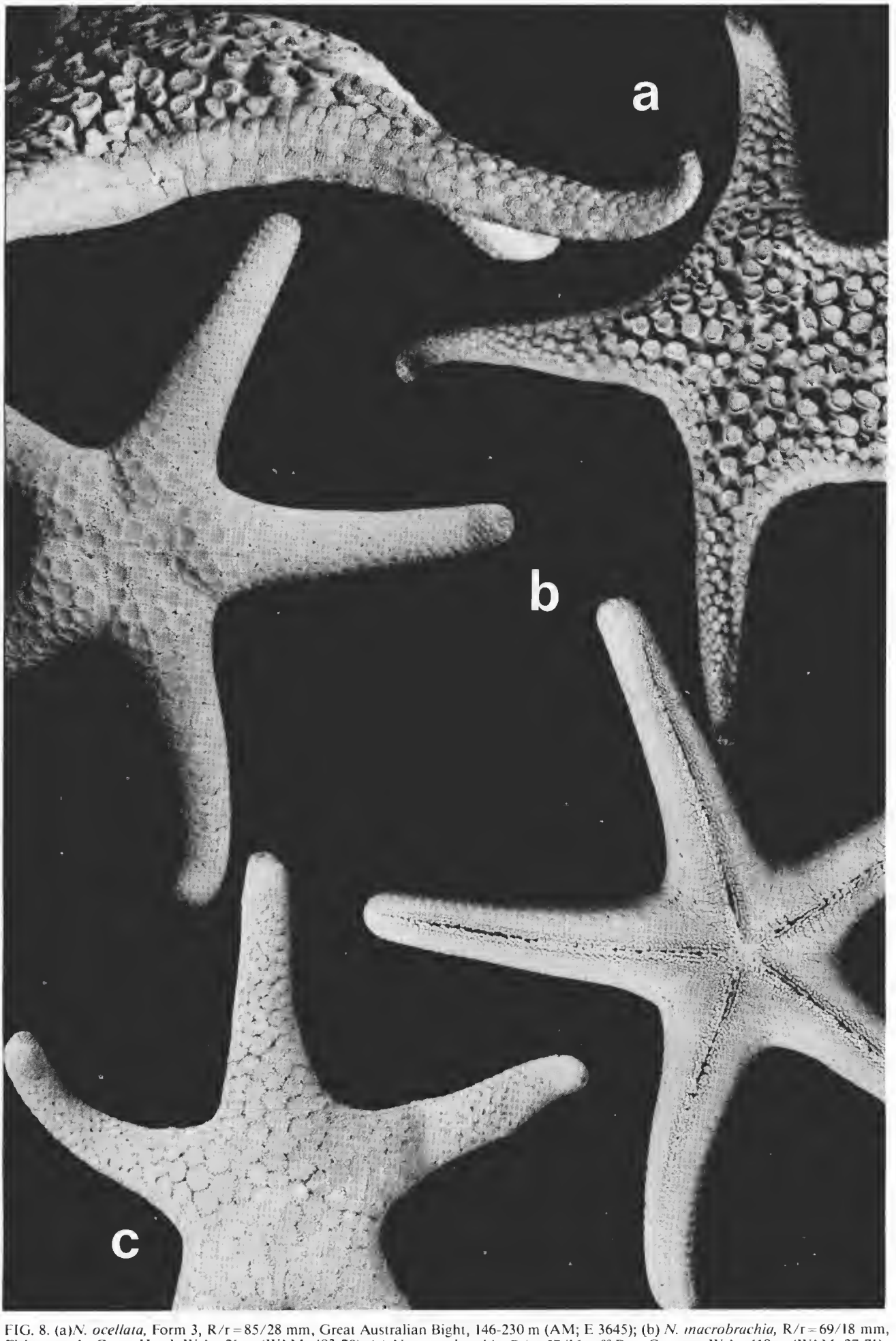

FIG. 8. (a)*N. ocellata,* Form 3, R/r = 85/28 mm, Great Australian Bight, 146-230 m (AM; E 3645); (b) *N. macrobrachia,* R/r = 69/18 mm, Fisherman I., Green Head, W.A., 21 m (WAM; 493-79); (c) *N. macrobrachia,* R/r = 57/16, off Port Gregory, W.A., 110 m (WAM; 27-71).

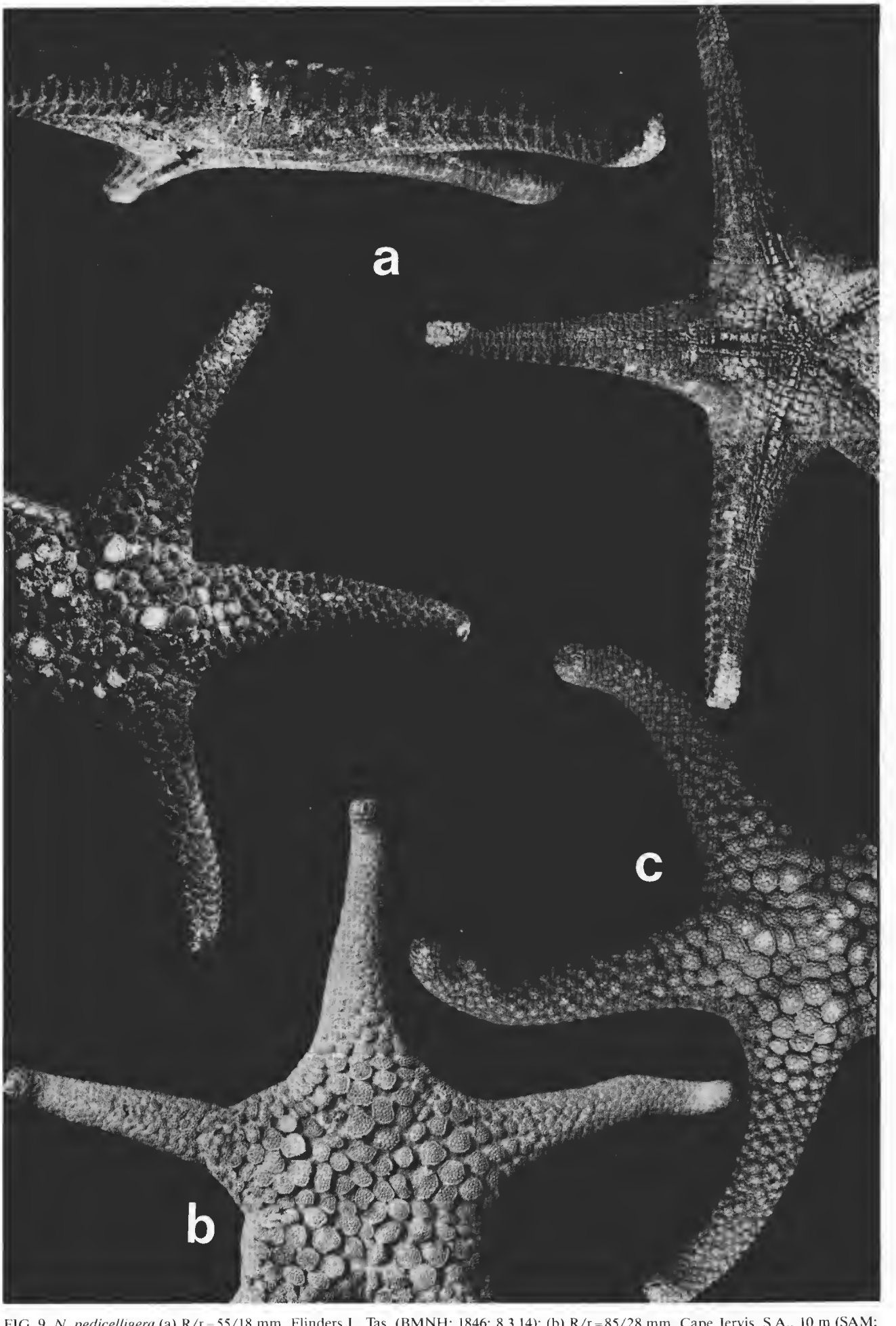

FIG. 9. *N. pedicelligera* (a) R/r = 55/18 mm, Flinders I., Tas. (BMNH; 1846: 8.3.14); (b) R/r = 85/28 mm, Cape Jervis, S.A., 10 m (SAM; K 596); (c) R/r = 85/25 mm, Doubtful Islands Bay, W.A., 1-2 m (WAM; 367-75).

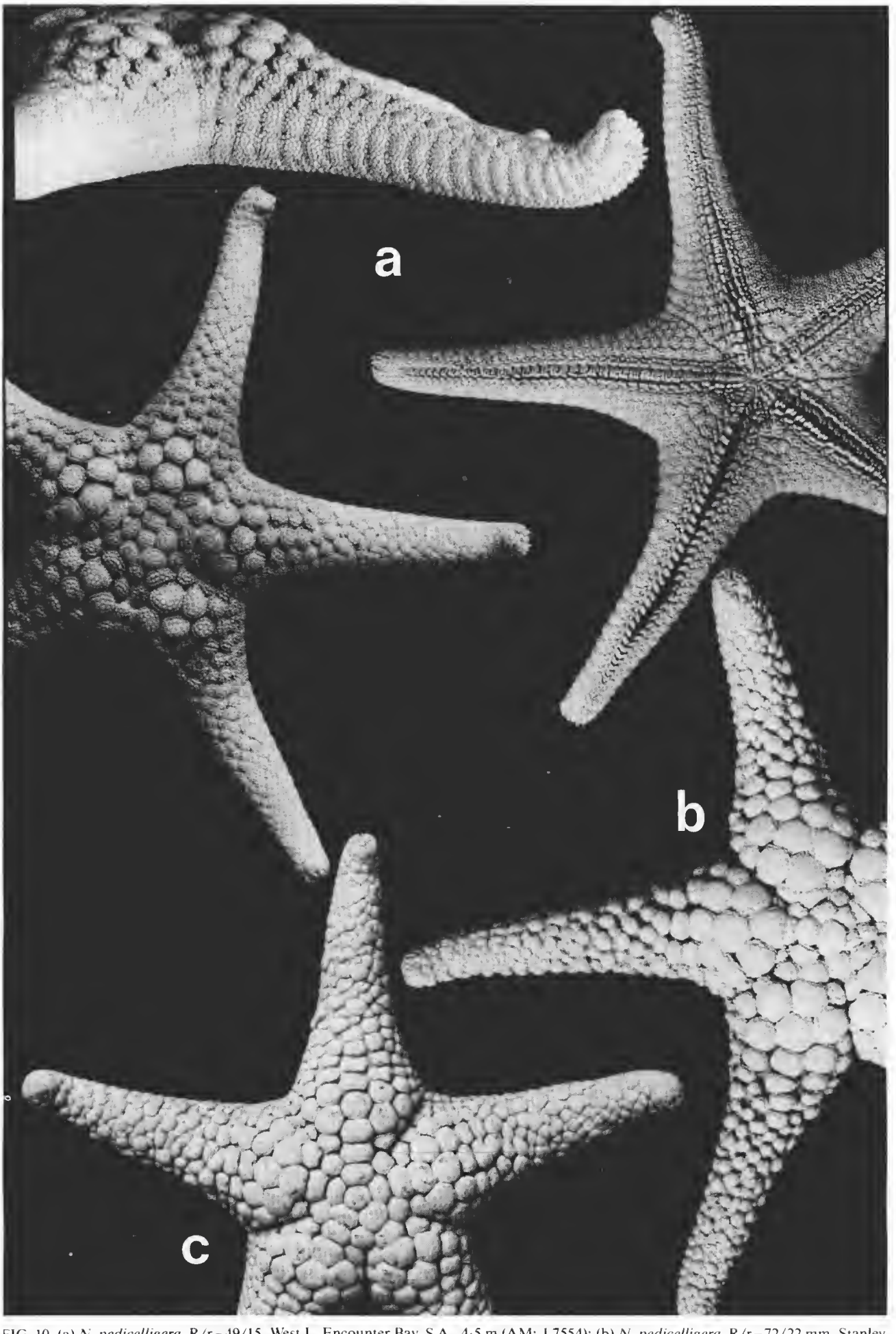

FIG. 10. (a) *N. pedicelligera*, R/r = 49/15, West I., Encounter Bay, S.A., 4·5 m (AM; J 7554); (b) *N. pedicelligera*, R/r = 72/22 mm, Stanley I., Denmark, W.A., 12-23 m (AM; J 12709); (c) *N. multispina*, R/r = 80/28 mm, Shoreham near Melbourne, Vic. (WAM; 1399-74).

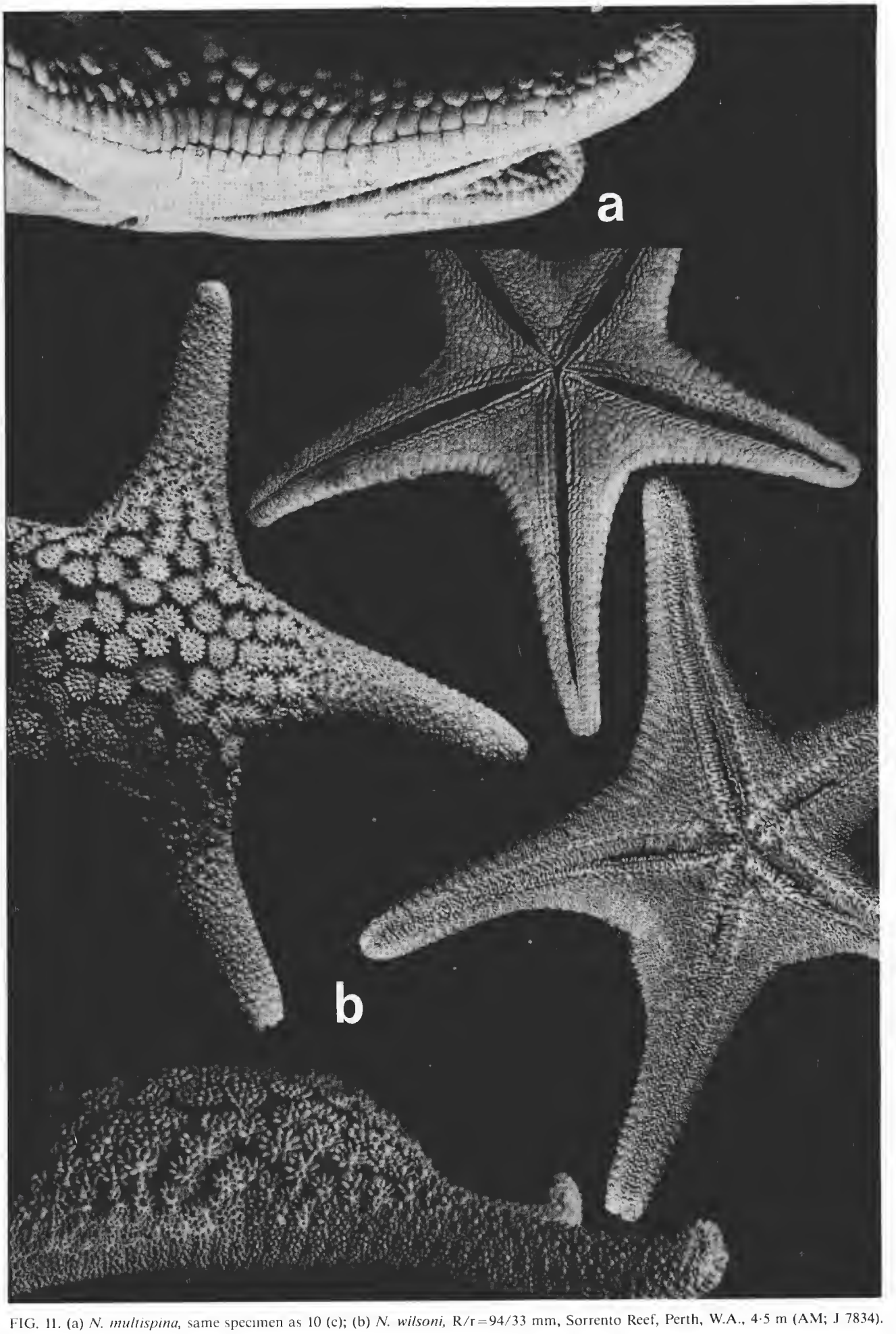

FIG. 11. (a) *N. multispina*, same specimen as 10 (c); (b) *N. wilsoni*, R/r=94/33 mm, Sorrento Reef, Perth, W.A., 4·5 m (AM; J 7834).

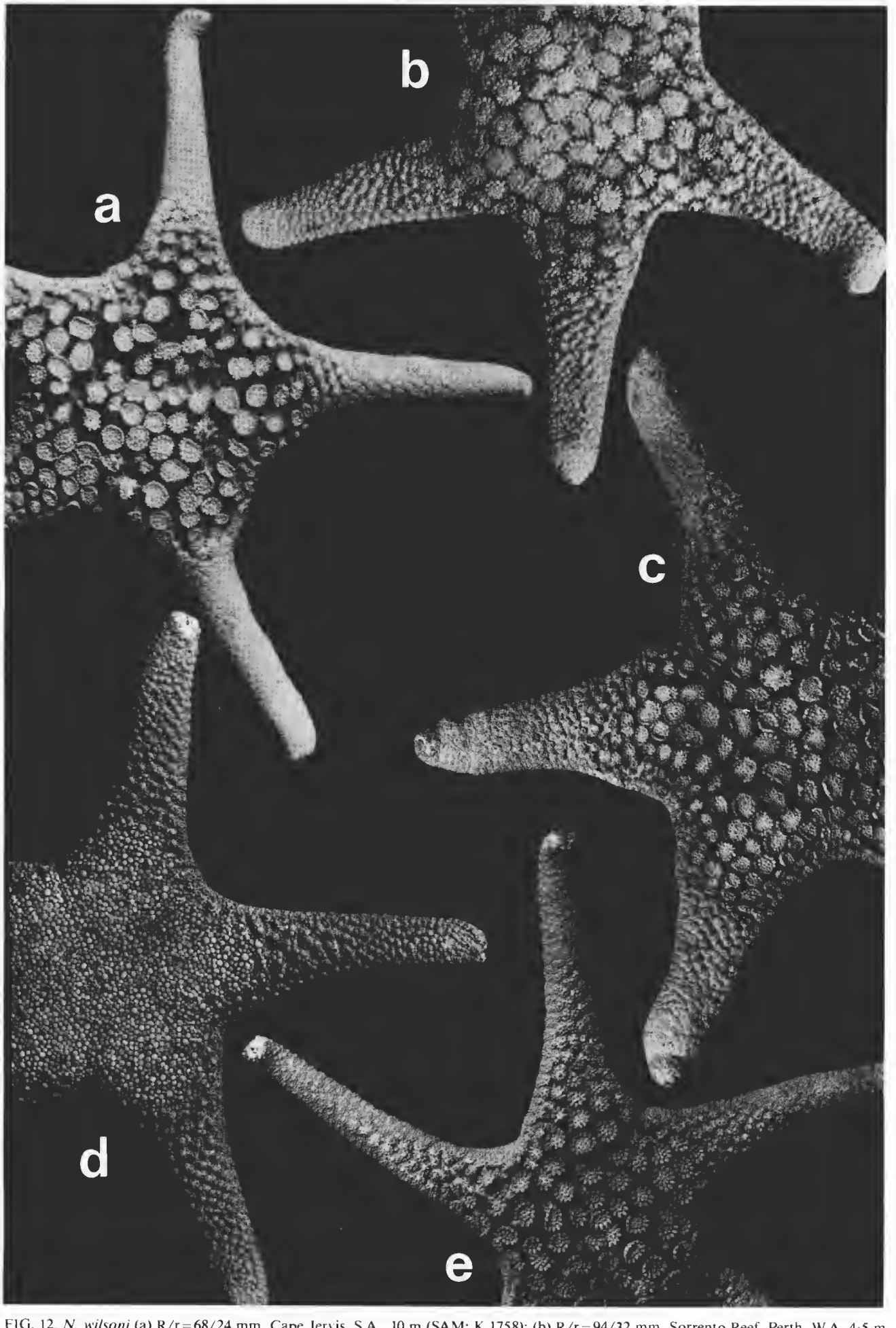

FIG. 12. *N. wilsoni* (a) R/r = 68/24 mm, Cape Jervis, S.A., 10 m (SAM; K 1758); (b) R/r = 94/32 mm, Sorrento Reef, Perth, W.A. 4·5 m (Paratype, WAM, 1395-74); (c) R/r = 120/42 mm, off Beagle I., W.A. (Paratype, WAM; 3-62); (d) R/r = 90/33 mm, Sorrento Reef, Perth, W.A. (Paratype, WAM; 2-65); (e) R/r = 64/18, off Dunsborough, Geographe Bay, W.A., 20-30 m (WAM; 746-76).

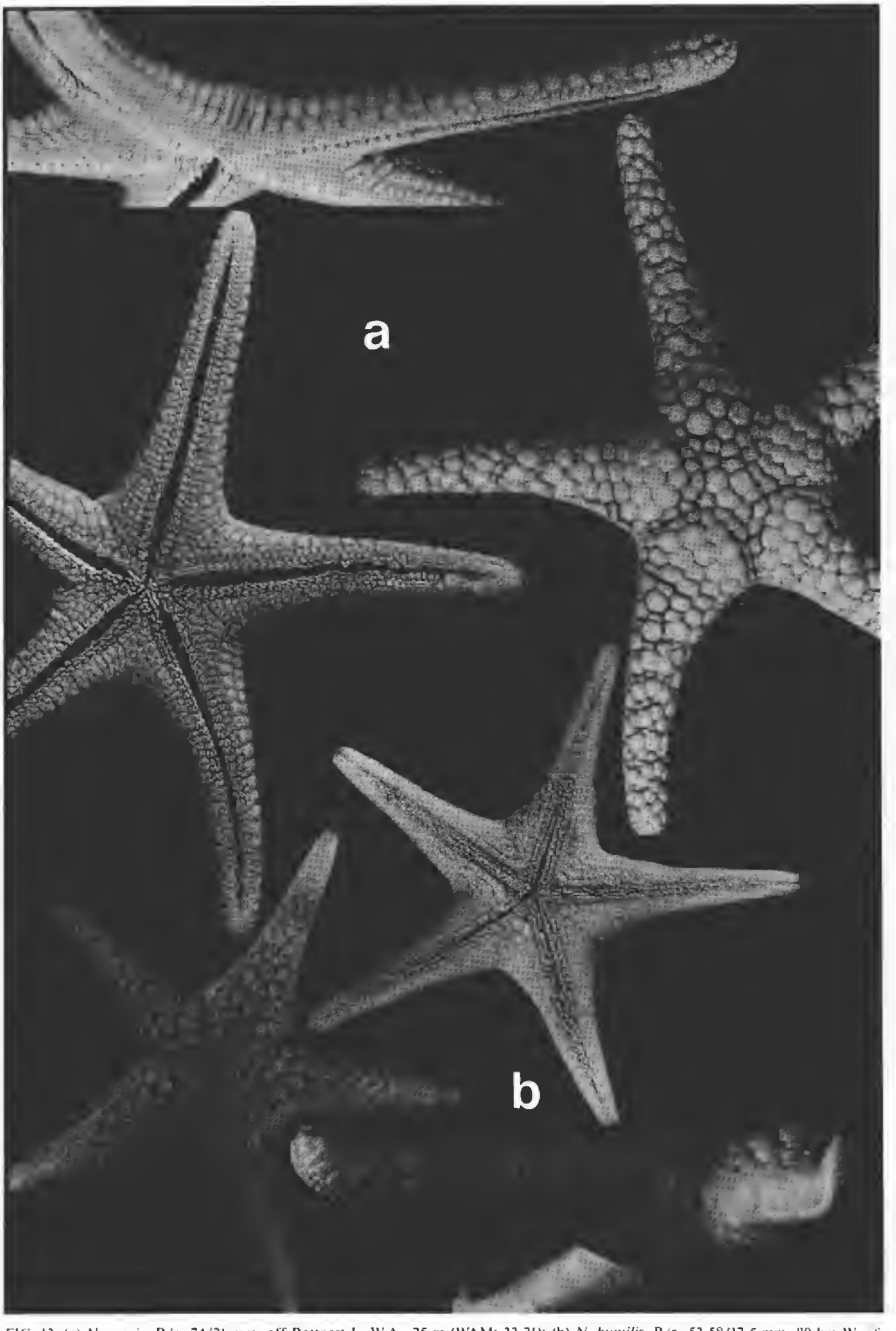

FIG. 13. (a) *N. saoria*, R/r = 74/21 mm, off Rottnest I., W.A., 25 m (WAM; 33-71); (b) *N. humilis*, R/r = 53-58/17·5 mm, 80 km W. of Woolnorth, Tas., 550 m (Holotype, TM; H 1476).

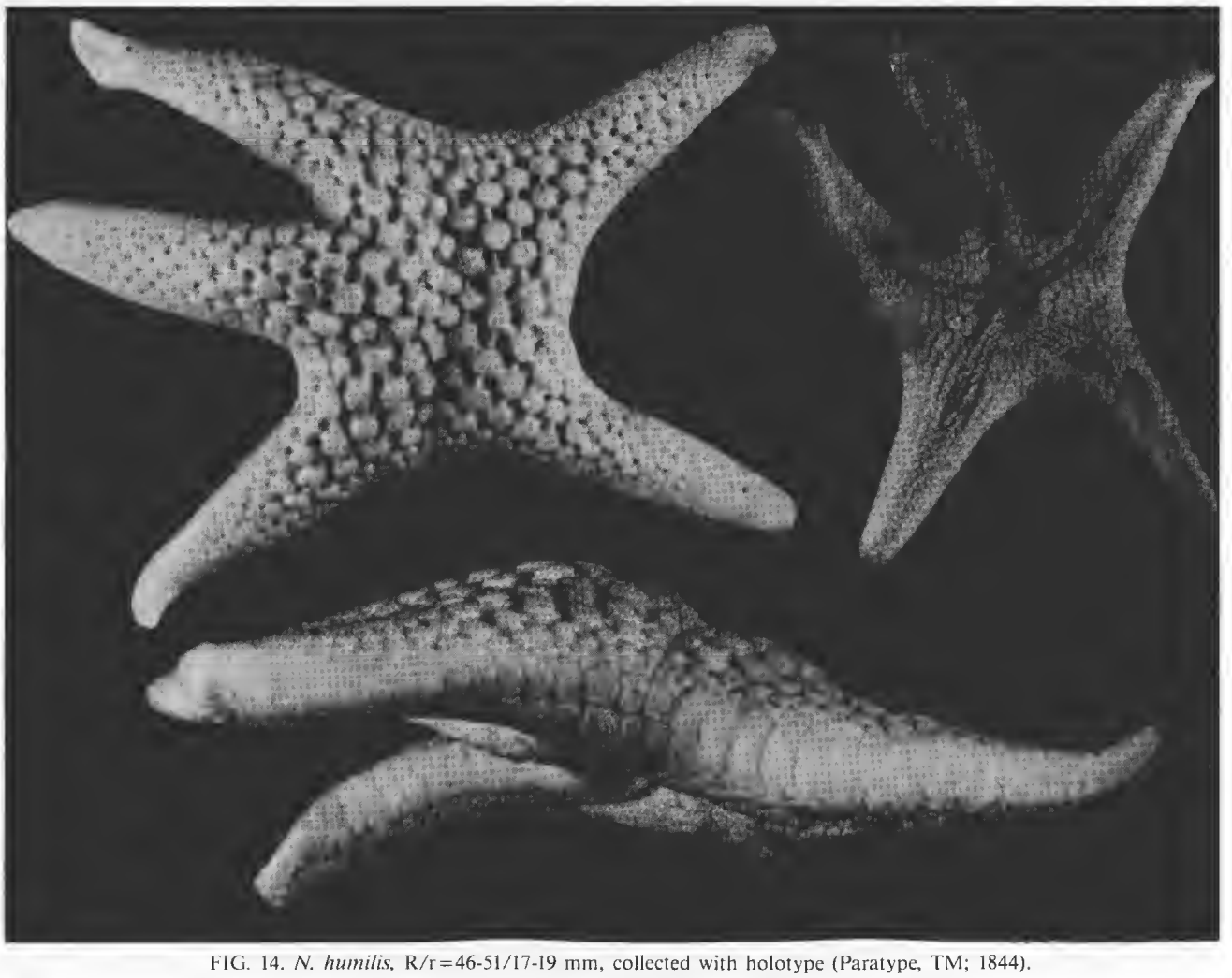

FIG. 14. *N. humilis*, R/r=46-51/17-19 mm, collected with holotype (Paratype, TM; 1844).